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WATER SUPPLY AND WATER QUALITY CONTROL STUDY, CEDAR POINT RESERVOIR, KANSAS

Federal Water Pollution Control Administration
Dallas, Texas

July 1966

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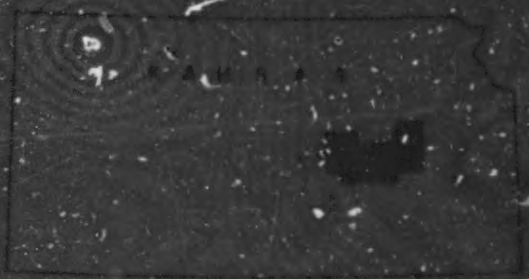

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WATER SUPPLY AND
WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR
KANSAS

A survey has been made which discloses a need for storage for future municipal and industrial water supplies and for streamflow regulation for the purpose of water quality control. These conclusions are based on results of economic, demographic, and hydrologic studies.

Prepared for

DEPARTMENT OF THE ARMY

U.S. Army Engineer District

Tulsa, Oklahoma

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Dallas, Texas

JULY 1966

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I. INTRODUCTION

Request and Authority

In a letter dated June 15, 1964, the U.S. Army Engineer District, Tulsa, Oklahoma requested that the Public Health Service* review the water quality control needs below Cedar Point Reservoir which were presented in earlier (Public Health Service) reports. [1/] In addition, the Public Health Service was requested to review previously reported water supply needs in the area. In a letter dated July 21, 1964, the Corps of Engineers requested that previously reported water supply and quality control needs be extended to include a period of 100 years.

This study has been made in accordance with (1) a Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare, dated November 4, 1953; and (2) the Federal Water Pollution Control Act (Public Law 84-660) as amended (33 U.S.C. 466 et. seq.).

Purpose and Scope

The purpose of this study was to examine information, previously supplied by the Public Health Service, which deals with water supply and quality control needs in the Grand (Neosho) River basin, as it pertains to the Cedar Point project study area. This study area was determined as Marion, Chase, and Lyon Counties, Kansas, which encompass the Cottonwood River watershed. The time period covered in the study was extended to the year 2070.

Acknowledgments

Appreciation is expressed to the following organizations who gave council and technical advice during the preparation of this report:

U.S. Army Engineer District, Tulsa, Oklahoma
Kansas Water Resources Board, Topeka, Kansas
Kansas State Department of Health, Topeka, Kansas
Department of Economics and Sociology, Kansas State University, Manhattan, Kansas

*In accordance with the Water Quality Act of 1965 (Public Law 89-234), approved October 2, 1965, the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et. seq.) is now administered through the Federal Water Pollution Control Administration.

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. Cedar Point Reservoir is an authorized Corps of Engineers multipurpose project which is located on Cedar Creek 4.2 miles above its confluence with the Cottonwood River. The project is designed for flood control, water quality control, and recreation.

2. The study area is composed of Marion, Chase, and Lyon Counties, located in east-central Kansas. This study area approximately encompasses the Cottonwood River drainage basin.

3. The 1960 population of the three-county study area was 45,992. Of this number, 27,802 was rural, and 18,190 were considered urban, all of which were located in the city of Emporia.

4. The major water-users and waste producers in the study area are the city of Emporia and the industries located therein. Principal sources of industrial water use and waste discharge are the cattle slaughtering and food processing industry. All municipal waste discharges receive secondary treatment.

5. The 1960 municipal and industrial water use in the study area was 2.78 million gallons per day (mgd), or an average per capita use of approximately 95 gallons per day. Emporia uses surface water as its source of supply while the majority of the smaller municipalities in the study area depend on ground water.

6. The quality of both ground and surface water supplies is acceptable, although rather hard before treatment. After conventional treatment, the water is suitable for municipal and industrial uses.

Conclusions

1. The study area population is expected to grow to 80,000 by 2020, with 60,000 people living in the urban areas. By 2070, the study area population is projected to be 130,000, of which 110,000 will be urban. The city of Emporia is expected to grow to 41,000 in 2020, and 73,000 in 2070.

2. Municipal and industrial water supply requirements for the study area are expected to increase to 10.2 mgd in

2020, and 18.4 mgd in 2070. The city of Emporia will need an additional source of supply by 2005. This need will grow to 7.0 mgd by 2070. Projections to the year 2070 indicate that storage to yield an additional 7.0 mgd for municipal and industrial water supply purposes will be needed. This storage could be provided by Cedar Point Reservoir.

3. Even after provision of adequate waste treatment, additional flow will be needed to maintain minimum dissolved oxygen requirements in the Cottonwood River to insure its usefulness for water supply, recreation, and fish and wildlife. This additional flow is estimated to be an annual draft-on-storage of 12,100 acre-feet by the year 2070. Marion Reservoir will provide 4,000 acre-feet per year. There is a need for storage to yield an additional 8,100 acre-feet per year for water quality control that could be provided by Cedar Point Reservoir.

4. If water supply storage to yield 7.0 mgd is provided in Cedar Point Reservoir, the present average annual benefit for this storage, as estimated by the cost of the most likely alternate in absence of the project, would be $83,700.

5. The average annual benefit from water quality control resulting from storage in Cedar Point Reservoir to provide a draft-on-storage of 8,100 acre-feet of water is estimated to be $316,860 on the basis of the cost of the most likely alternative in absence of the project.

6. Benefits from water quality resulting from storage in Cedar Point Reservoir will be widespread in scope. These benefits from storage for water quality control are based on the provision of adequate treatment of wastes discharged to affected stream reaches.

III. PROJECT DESCRIPTION

Location

The project under restudy is Cedar Point Reservoir located on Cedar Creek in Chase County, Kansas. As presently authorized, Cedar Point Reservoir has 15,800 acre-feet of storage allocated to water quality control. The current plan under investigation is the development of the project site to its maximum feasible conservation storage, or 65,400 acre-feet. As shown in figure III-1 following page X-2, Cedar Creek is a tributary to the Cottonwood River which flows into the Neosho River about seven miles east of Emporia, Kansas.

Pertinent Data

The reservoir is being considered as a multipurpose project for flood control, recreation, and water quality control. When built, Cedar Point Reservoir will be part of a system of reservoirs contributing to the development of water resources in the Neosho River basin in the State of Kansas. Other projects include recently completed Council Grove and John Redmond Reservoirs, and Marion Reservoir, which is under construction.

Table III-1

Pertinent Data
Cedar Point Dam and Reservoir

Location	Cedar Point, Kansas	
Stream	Cedar Creek	
River Mile	4.2	
Drainage Area	119 square miles	
Type	Earthfill Embankment	
Storage, Acre-feet	Authorized Project	Current Plan
Flood Control	36,200	37,100
Water Quality Control	15,800	65,400
Sedimentation	3,000	6,100
Total	55,000	108,000
Water Quality Control Yield	2.7 mgd	7.2 mgd

Source: Corps of Engineers 2/

IV. STUDY AREA DESCRIPTION

Location

The study area consists of Marion, Chase, and Lyon Counties, located in east-central Kansas. The area is shown in figure III-1 following page X-2. These counties approximately encompass the Cottonwood River drainage area, the area which would reasonably be affected by water resources development of Cedar Creek to the degree under current study.

Climate and Geography

The study area is rolling prairie land, ranging in elevation from 1,100 to 1,500 feet above sea level. Most of the land is devoted to crops and stock grazing. There is very little timber.

Located at the geographical center of the country, the area has a distinctly continental climate with characteristically changeable temperature and precipitation. Mean annual temperature is 54° F., ranging from an average of 30° F. in January to 80° F. in July. Mean annual precipitation ranges from 30 to 36 inches, west to east. 3/

Principal Communities and Industries

The economic base of the study area is agriculture and agricultural processing, and service industries.

Emporia, with a 1960 population of 18,190, is the only town of major size in the study area. Emporia is located on the Cottonwood River near its confluence with the Neosho River (see figure III-1).

V. WATER RESOURCES OF THE STUDY AREA

Reservoirs

There are at present no major reservoirs in the Cottonwood River watershed. Marion Reservoir, located on the upper reaches of the Cottonwood River (see figure III-1), is under construction and when completed in 1968 will have 60,000 acre-feet of flood control storage, and 86,800 acre-feet storage for water supply and water quality control. 4/ Marion Reservoir will have a water supply yield of 3.0 mgd and a water quality control yield of 3.55 mgd (4,000 acre-feet per year). 5/

Adjacent to the Cottonwood River watershed are two reservoirs on the Neosho River recently completed - Council Grove and John Redmond Reservoirs. Council Grove Reservoir has an initial flood control storage of 76,000 acre-feet. Future adjustments of storage will provide a water supply yield of 6 mgd. John Redmond Reservoir has an initial flood control storage of 588,100 acre-feet, and an initial conservation storage of 56,700 acre-feet. Future reassignment of storage will provide a water supply yield of 24.5 mgd. 4 5/

Marion, Council Grove, John Redmond, and Cedar Point Reservoirs will operate as a system in providing flood protection for the entire Neosho River Valley in the State of Kansas.

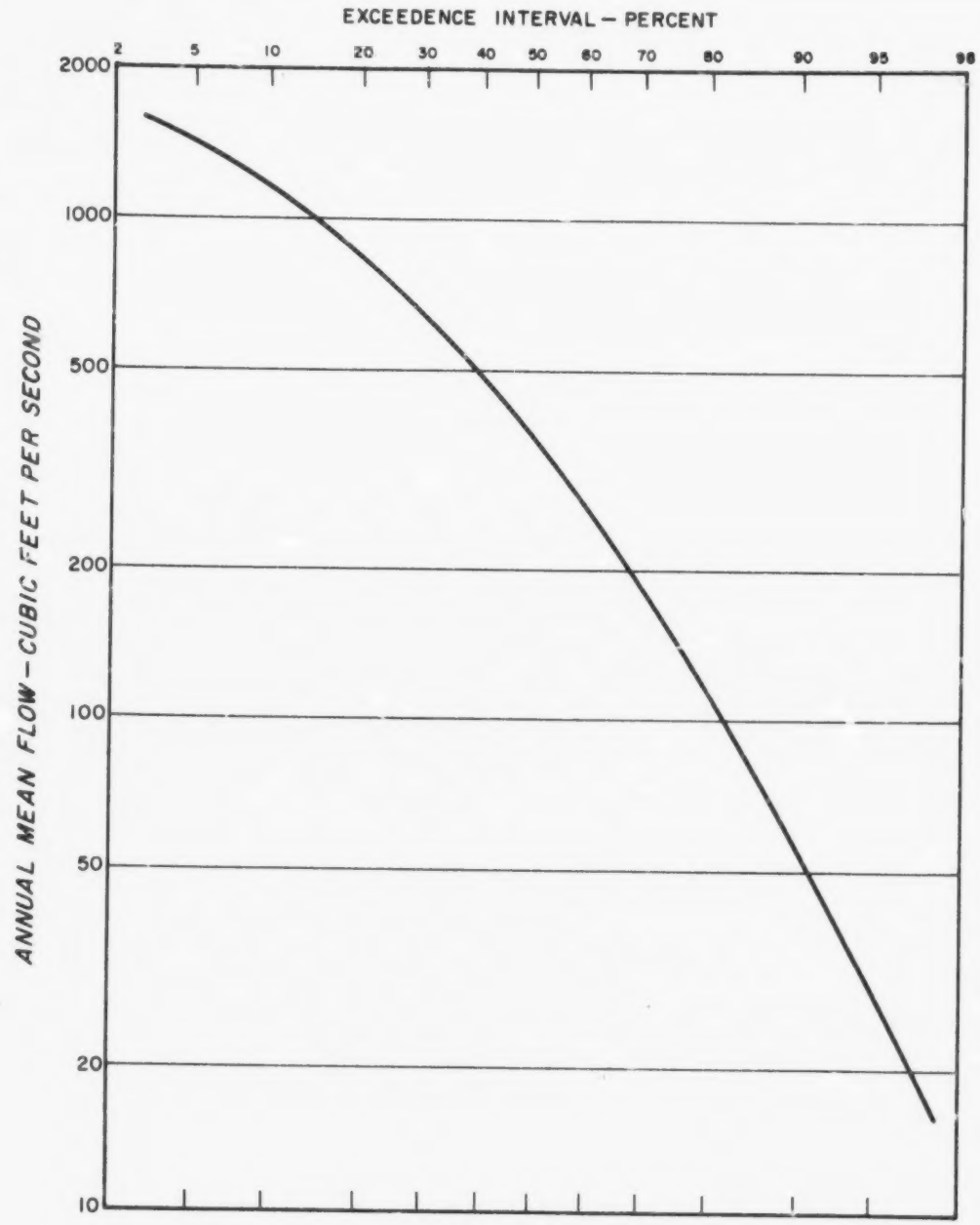
Streamflow

Streamflows in the Cottonwood River watershed are marked by wide ranges in magnitude.

The Cottonwood River near Marion has an average annual discharge of 115 cubic feet per second (cfs), with instantaneous flows ranging from zero to a maximum of 66,000 cfs. 6/

The Cottonwood River gage at Cottonwood Falls, drainage area 1,327 square miles, has an average annual flow of 510 cfs, with extremes ranging from zero to 196,000 cfs. 6/ Figure V-1 shows the annual mean flow frequency at this gage. Figure V-2 shows the median monthly distribution as a percent of the mean annual flow. As can be seen from this chart, highest flows can be expected in May and June with the lowest flows expected in August and December.

Twenty-six years of streamflow records on Cedar Creek near Cedar Point and the project damsite, drainage area 110 square miles, show an average annual flow of 53.3 cfs, with a minimum of zero and a maximum of 52,400 cfs. 6/ Figure V-3 shows the frequency of occurrence of annual mean flow frequency of Cedar Creek at this gage. As is shown, extremely low annual flows can be expected at a 90 percent



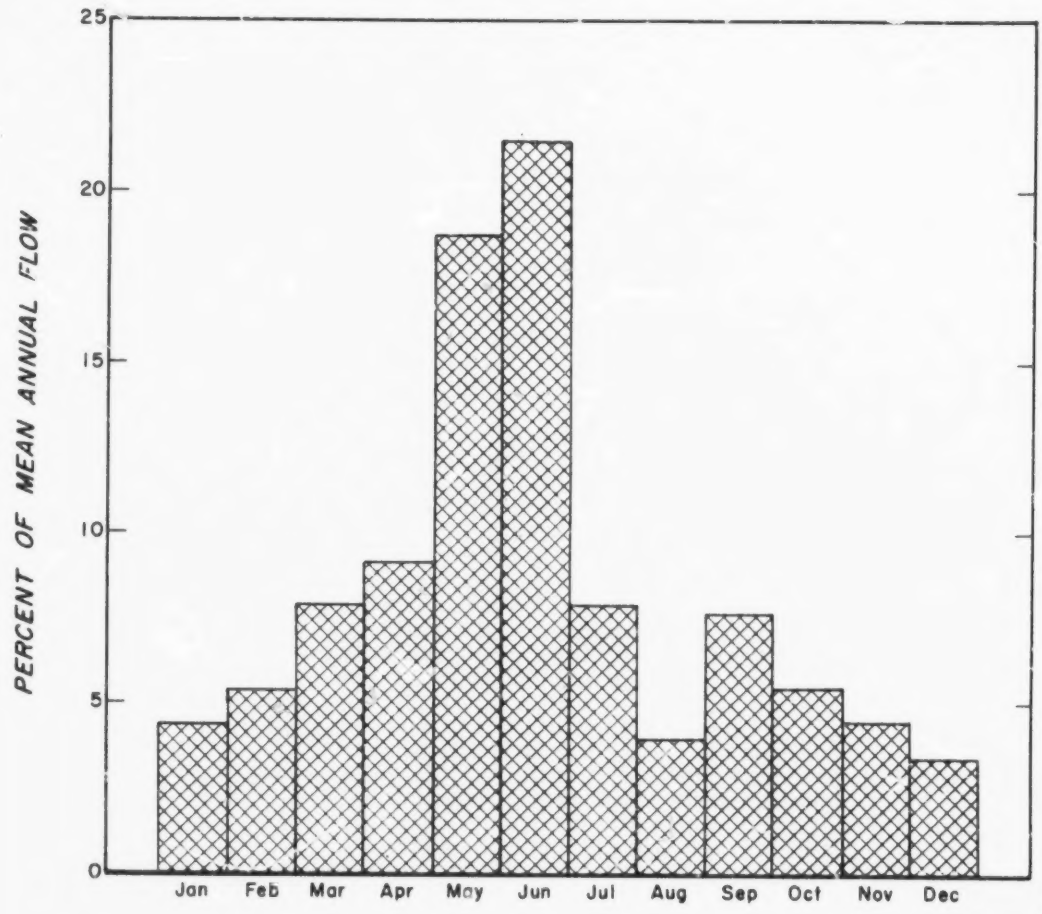
WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR – CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

ANNUAL MEAN FLOW FREQUENCY

COTTONWOOD RIVER AT COTTONWOOD FALLS

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR. 15, 1966 DALLAS, TEXAS

FIGURE V – 1

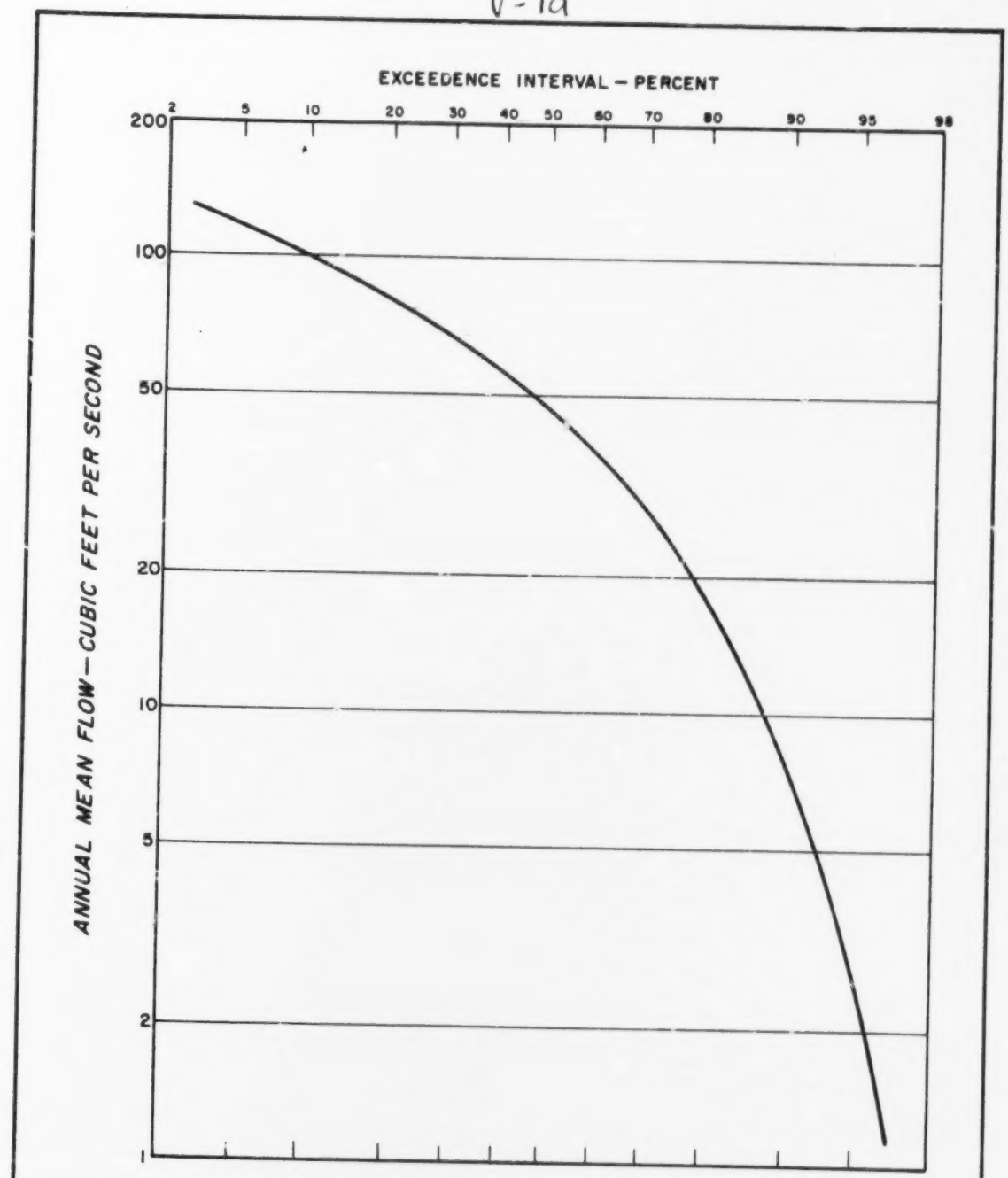


WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR–CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

MONTHLY DISTRIBUTION OF ANNUAL FLOW
COTTONWOOD RIVER AT COTTONWOOD FALLS

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR. 15, 1966 DALLAS, TEXAS

FIGURE V-2



WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR – CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

ANNUAL MEAN FLOW FREQUENCY

CEDAR CREEK NEAR CEDAR POINT

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR. 15, 1966 DALLAS, TEXAS

FIGURE V – 3

exceedence (once-in-10 years) or greater. Figure V-4 shows the median monthly distribution as a percent of mean annual flows on Cedar Creek, with the greatest flows expected during spring and early summer.

Chemical Quality of Streamflows

In general, the chemical quality of surface water in the study area is acceptable, although hard. Shown below in table V-1 is the chemical quality of the Cottonwood River at Emporia.

Table V-1

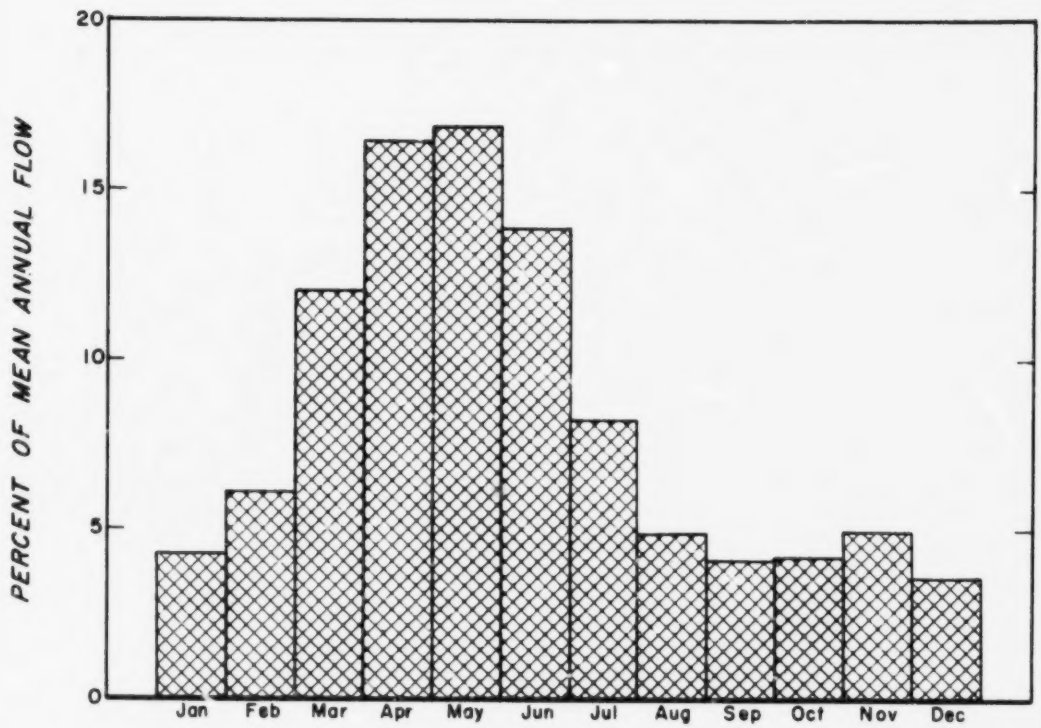
Chemical Quality of the Cottonwood River at Emporia
May 1955 to March 1960

Constituent	Concentration (mg/l) Max.	Min.	Avg.	Public Health Service Standards (mg/l)
Total Dissolved Solids	697	145	438	500
Sulfate	274	22	114	250
Chloride	87	6	47	250
Total Hardness	538	116	330	

Source: Kansas State Board of Health 7/

Ground Water

The Cottonwood River Valley across Chase and Lyon Counties is underlain by sand and gravel deposits in which wells can be developed that will yield up to 150 gallons per minute (gpm). 8/ Small quantities of water are presently being withdrawn for domestic and stock uses. However, because the yield of these alluvial deposits are dependent upon surface streamflow, the yields are reduced significantly during periods of prolonged drought when the saturated material is depleted by pumping and natural discharge. Thus, ground water as a source of water supply cannot be depended upon by large water-users during periods of drought. The ground water is also slightly less desirable in quality than the areas' surface waters.



WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR–CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

MONTHLY DISTRIBUTION OF ANNUAL FLOW

CEDAR CREEK NEAR CEDAR POINT

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FIGURE V–4

VI. THE ECONOMY

An economic evaluation was made of the three-county Cedar Point study area, the resulting projections of population and industrial growth serve as a basis for estimating future water use requirements and subsequent waste discharges.

Present

Economic Geography

The study area is located about midway between Topeka and Wichita in east-central Kansas. The area is served by two U.S. Highways, one interstate highway, and numerous State highways, as well as rail and air service. Emporia is the largest city in the study area and accounts for the entire 1960 urban population shown in table VI-1. The urban increase of nearly 5,000 people failed to offset the 10,000 rural losses, resulting in a net decrease of about 6,000 people between 1940 and 1960. About 40 percent of the 1960 study area population resided in urban areas compared to 61 percent for the State of Kansas, and 70 percent for the Nation. In addition to Emproia, the towns of Hillsboro, Marion, Peabody, Florence, Cottonwood Falls, and Strong City are considered significant in this study. Their 1940, 1950, and 1960 populations are shown in table VI-1.

Table VI-1

Study Area Population 1940, 1950, and 1960

City	1940	1950	1960
Strong City	848	680	659
Cottonwood Falls	1,078	957	971
Emporia	13,667	15,669	18,190
Hillsboro	1,580	2,150	2,441
Marion	2,086	2,050	2,169
Peabody	1,367	1,194	1,309
Florence	1,329	1,009	853
URBAN	13,667	15,669	18,190
RURAL	38,058	32,045	27,802
TOTAL	51,725	47,714	45,992

Source: Bureau of the Census 9/

Resources Within the Area

Much of the economy of the study area is built around agriculture. Table VI-2 shows agricultural statistics for the years 1944 through 1959. As shown in table VI-2, value of farm products has increased rapidly, more than doubling, between 1944 and 1959. The value of livestock sold accounted for 80 percent of the total value of farm products in the study area in 1959. Much of the increase in livestock values can be attributed to increased cattle marketing. In 1962, 186,000 cattle were sold in the study area with 70 percent of the number being grainfed cattle. [10] Most grainfed cattle were concentrated in commercial feedlots in an area 50 miles around Emporia. Feedlots in this area have capacities to produce approximately 225,000 fat cattle annually. [11] In addition to commercial feedlot cattle, the study area produces farmfed cattle and grassfed cattle from the vast Flint Hills pasture. Fifty-seven thousand grassfed cattle were marketed in the study area in 1962.

Table VI-2

Agricultural Statistics for the Study Area
1944, 1949, 1954, 1959

	1944	1949	1954	1959
Number of Farms	5,201	4,665	4,311	3,691
Acres of Cropland Harvested	607,192	554,834	580,680	548,653
Value* of All Crops Sold	4,456	8,086	8,450	10,882
Value* of All Livestock & Livestock Products Sold	21,721	20,461	23,631	42,914
Total Value* of All Farm Products Sold	26,177	28,548	32,081	53,796

*All values in 1,000's of 1960 dollars.

Source: Bureau of the Census [12]

The value of minerals produced in the study area in 1961 was over $11 million. [13] Most of this value resulted from the sale of petroleum and petroleum products.

Manufacturing

Manufacturing employment increased nearly five-fold between 1940 and 1960 as shown in table VI-3. Food and kindred processing is the most significant manufacturing industry, with employment in this industry accounting for over a third of the 1960 manufacturing employment. The abundance of fat cattle in the area is one of the major factors causing Armour and Company to build a beef-killing plant in Emporia. [14]

The beef abattoir began operation in 1964. The plant employs approximately 100 people and has a slaughter capacity of over 100,000 cattle annually. This plant will supplement the operations of slaughter facilities presently located in Emporia which kills approximately 12,000 to 40,000 hogs annually. Employment data for this plant are not reflected in the 1960 manufacturing employment in table VI-3. In addition to the Armour facility in Emporia, a large dairy operates in Hillsboro. Other significant industries in the study area are a plant making canvas goods in Emporia, a plant making printing presses in Emporia, a plant making oilfield tanks in Emporia, and a plant making aircraft parts in Peabody. 15/

Table VI-3

Study Area Employment 1940, 1950, and 1960

	1940		1950		1960	
	Number	%	Number	%	Number	%
Agriculture (Forestry & Fisheries)	7,147	38.3	5,648	32.0	3,809	20.9
Mining	118	0.6	180	1.0	348	1.9
Manufacturing	383	2.0	834	4.8	1,809	9.9
Fabricated Metals	-	-	8	0.1	64	0.4
Machinery, except electrical	7	-	56	0.3	165	0.9
Electrical Mach., Equip., & supplies	-	-	27	0.1	72	0.4
Trans. Equipment, except motor	-	-	5	0.1	193	1.1
Food & Kindred Prod.	208	1.1	395	2.2	647	3.5
Apparel & Other Textile Products	6	-	14	0.1	190	1.0
Printing, Pub., & Allied Products	149	0.8	195	1.1	358	1.9
Other	13	0.1	134	0.8	120	0.7
Service and Other	9,155	49.0	10,688	60.6	11,836	64.9
Unemployed	1,888	10.1	282	1.6	439	2.4
Total Labor Force	18,691	100.0	17,632	100.0	18,241	100.0
Population	51,720		47,714		45,992	
Labor Force Participation		36.1		37.0		39.7

Source: Bureau of the Census 16/

Future

Much of the future growth of the study area is expected to be centered around the cattle feeding and meat processing industries in Emporia. According to Resources for the Future median projection, the national demand for beef is expected to more than double by the year 2000. 17/ The shift to low-cost Kansas grown feed grains will be the dominate factor behind future cattle feeding in the area. Cattle production is expected to triple by 2020. The continued increase of study area cattle production will create a need for additional slaughter facilities. Slaughter facilities are expected to more than double by 2020. On the basis of the industrial analysis previously described, tempered by past and anticipated growth of the State and Nation, employment projections for the study area were developed for 2020. They are shown in table VI-4.

Table VI-4

2020 Study Area Employment Projections

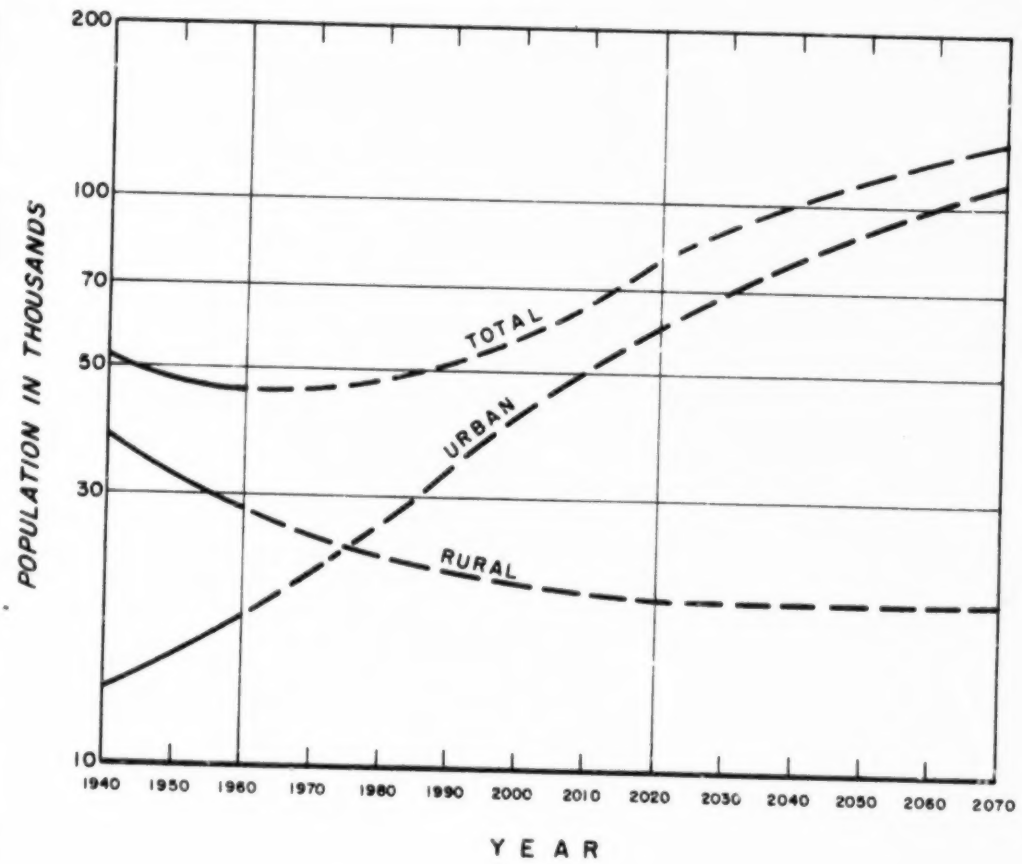
	1960		2020	
	Number	Percent	Number	Percent
Agriculture	3,809	20.9	3,000	9.3
Mining	348	1.9	500	1.6
Manufacturing	1,809	9.9	6,000	18.7
Service and Other	11,836	64.9	21,220	66.4
Unemployed	439	2.4	1,280	4.0
Total Labor Force	18,241	100.0	32,000	100.0
Population	45,992		80,000	
Labor Force Participation		39.7		40.0

The study area population has been declining over recent years. Therefore, the area population was projected to grow at an annual compounded rate less than most projected annual growth rates for the State of Kansas and the entire Nation. Study area population is projected to grow to 80,000 in 2020, with 60,000 of the 80,000 residing in urban areas. To provide a framework for analyzing water requirements and waste discharges, these projections were disaggregated to the larger towns in the study area. As shown in table VI-5, because of their close proximity (less than two miles apart), and their economic inter-dependence, projections for Strong City and Cottonwood Falls were combined. For the 50-year period from 2020 to 2070, population is used as an indicator of water requirements. As shown in table VI-5 and figure VI-1, total population is expected to reach 130,000 by 2070 with more than 80 percent of the projected population residing in urban areas.

Table VI-5

Population Projections to 2020 and 2070

City	1960	2020	2070
Strong City & Cottonwood Falls	1,630	4,000	8,000
Emporia	18,190	41,000	73,000
Hillsboro	2,441	5,000	9,000
Marion	2,169	4,500	8,000
Peabody	1,309	3,000	6,000
Florence	853	2,500	6,000
URBAN	18,190	60,000	110,000
RURAL	27,802	20,000	20,000
TOTAL	45,992	80,000	130,000



WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR-CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

POPULATION TRENDS & PROJECTIONS
STUDY AREA

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR. 15,1966 DALLAS, TEXAS

FIGURE VI-1

VII. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Present

Emporia, the only large municipality in the study area, presently withdraws its water supply from its municipal lake, Lake Kahola, and the Neosho and Cottonwood Rivers. Emporia's average consumption is presently 2.0 mgd, or a per capita use of approximately 100 gallons per day (gpcd). The other small towns in the area, as presented in Section VI, presently withdraw their water supplies from alluvial wells, except Marion, which has an impoundment on Mud Creek. The 1960 total water use of these small towns was 0.78 mgd, or an average per capita use of 90 gpcd.

Presented below in table VII-1 is a summary of the present water use and source of supply for the towns in the study area.

Table VII-1

Present Municipal and Industrial Water Use
(mgd)

Town	1960 Water Use	Source of Supply
Emporia	2.00	Lake Kahola, Neosho and Cottonwood Rivers
Strong City	0.04	Wells
Cottonwood Falls	0.09	Wells
Hillsboro	0.16	Wells
Marion	0.30	Mud Creek Impoundment
Peabody	0.11	Wells
Florence	0.08	Spring

Source: Public Health Service 18/

There are no major industrial water users in the area. The small industries currently obtain their water supplies from the municipal systems, and are therefore included in the above water use figures.

Future

The per capita water use for Emporia is projected to grow from a current 100 gpcd to 175 gpcd by 2020. The per capita use in the other municipalities in the study area is expected to grow from a present 90 gpcd to 150 gpcd. These projected per capita water uses

are intended to include industrial water users, which will most likely be supplied by the municipal systems. A larger per capita water use was projected for Emporia because of its expected greater industrial development. These projections were based on current water trends in cities of comparable population to which the study area towns are expected to grow, as well as climate and rainfall factors of the study area, which affect per capita water use.

Based on the population projections presented in Section VI, and the gallons per capita water use discussed above, the projected municipal and industrial water use for the study area is presented in table VII-2. Strong City and Cottonwood Falls are projected as a single entity because of their close proximity to each other as well as similar water needs and uses.

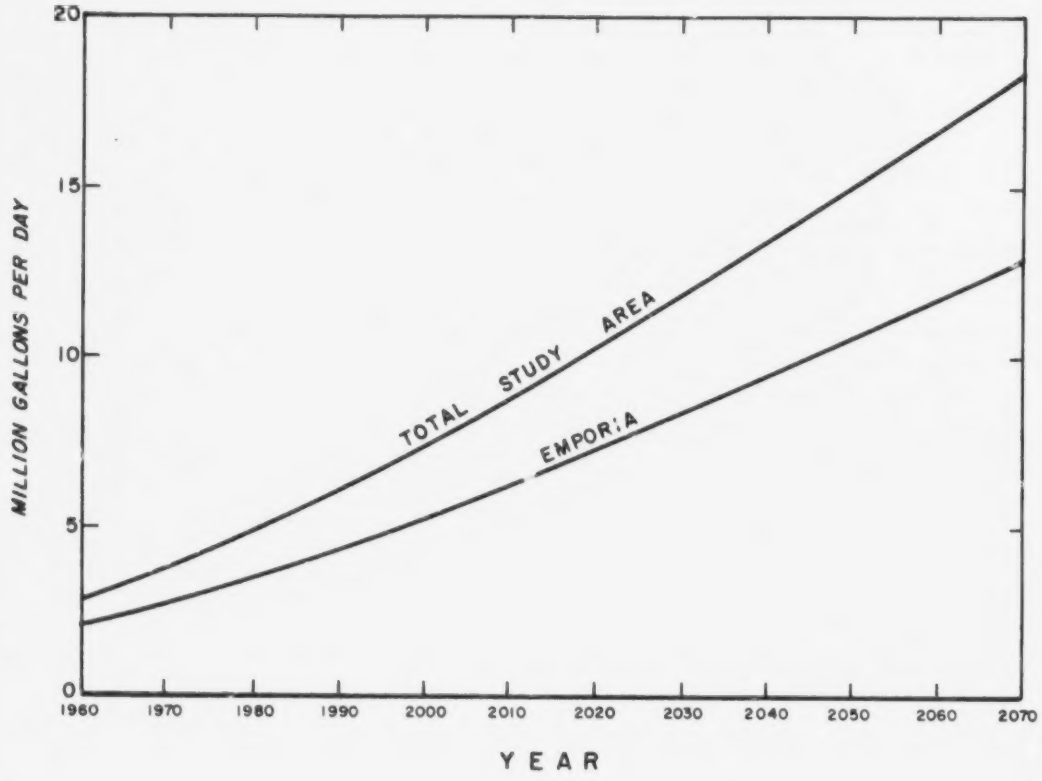
Table VII-2

Study Area Municipal and Industrial Water Use Projections

Town	Projected (gpcd)	2020 Population	2020 Water Use (mgd)	2070 Population	2070 Water Use (mgd)
Strong City Cottonwood Falls	150	4,000	0.6	8,000	1.2
Hillsboro	150	5,000	0.8	9,000	1.4
Marion	150	4,500	0.7	8,000	1.2
Florence	150	2,500	0.4	6,000	0.9
Peabody	150	3,000	0.5	6,000	0.9
Subtotal		19,000	3.0	37,000	5.6
Emporia	175	41,000	7.2	73,000	12.8
Total		60,000	10.2	110,000	18.4

The municipal and industrial water use growth as projected from 1960 to 2070 is shown on figure VII-1.

A water supply plan for meeting the 2070 needs for the study area is presented in table VII-3. Marion and Hillsboro have each furnished a resolution for one mgd of future water supply storage in Marion Reservoir, and Emporia has furnished assurances for 3 mgd of future water supply storage in Council Grove Reservoir. (See figure III-1.) Emporia's present source of supply has an estimated dependable yield of 2.8 mgd. Thus, Emporia will need an additional source of 7.0 mgd for municipal and industrial water supply by the year 2070. The year of first need of this additional source is 2005. Since all conservation storage in Cedar Point Reservoir is currently proposed to meet projected water quality control needs as presented in the following chapter VIII, other sources of supply will need to



WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR-CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

M & I WATER USE PROJECTIONS

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR. 15, 1966 DALLAS, TEXAS

FIGURE VII-1

be obtained if future municipal and industrial water supply needs of Emporia are to be met. Possible future sources include a reallocation of storage in Cedar Point Reservoir or water supply storage in John Redmond Reservoir if its total yield is not allocated to other communities below the reservoir before Emporia's year of first need. The remaining communities in the study area could best meet their water demands by developing their present well fields, since their projected demands are all less than 1.0 mgd, and their well fields are capable of yielding this amount.

Table VII-3

Study Area Water Supply Plan

	2070 M&I Demand (mgd)	Source (mgd)			
		Present*	Marion Reservoir	Council Grove Reservoir	Cedar Point or Other Reservoirs
Emporia	12.8	2.8	0	3.0	7.0
Other Towns	5.6	2.6	3.0	0	0

* Includes present surface and ground water supplies and future development of ground water supplies.

VIII. WATER QUALITY CONTROL

Water Quality Objectives

The primary objective in providing regulated flows for water quality control is to maintain or improve the quality of flows in streams receiving treated wastes, so that the water will be suitable for downstream reuse. Even with adequate sewage treatment, using a stream to carry away the effluent usually results in an increase in the load of dissolved materials, principally organics. Water quality control releases provide the additional water needed to assimilate these wastes. The releases also serve to maintain the usefulness of the stream for wildlife and recreational purposes. Another purpose for maintaining water quality control on the Cottonwood River is to protect the quality of John Redmond Reservoir, which is located on the Neosho River immediately below the Cottonwood River confluence. Polluted waters entering this reservoir could endanger its use for water supply storage.

The parameter used as an indicator of the water quality of the Cottonwood River was dissolved oxygen. An adequate amount of dissolved oxygen in a stream is not only necessary for the preservation and propagation of aquatic life, but also in order for natural stream self-purification process to occur.

In nature, clean waters are saturated with dissolved oxygen, or nearly so. Normally, therefore, waste matters discharged into natural water undergo aerobic decomposition. Only when the supply of oxygen present in solution or taken into solution, principally from the atmosphere, cannot keep pace with the biochemical oxygen demand (BOD) of the waste matters does the receiving water, and with it the type of decomposition, become anaerobic. Although the ultimate result of both types of decomposition is a purified water, the conditions associated with each are different. Under aerobic conditions, the receiving waters remain reasonably clean in appearance and free from odor. Such waters continue to support their normal animal and plant populations. Under anaerobic conditions, the waters become black, unsightly, and malodorous, and their normal fauna and flora are destroyed. A septic receiving water usually creates a nuisance that makes itself felt over long reaches of the stream, because anaerobic decomposition is much slower than aerobic decomposition.

For the maintenance of normally satisfactory conditions, therefore, the oxygen economy of the receiving water is of paramount consideration. In order to maintain a balance, biochemical oxygen demand must not exceed the available oxygen supply. If the dissolved oxygen supply is exceeded, additional oxygen can be added through augmenting the natural flow of the receiving stream by releasing dilution flows from reservoir storage.

Sources of Pollution

There are three major potential sources of pollution on the Cottonwood River.

Municipal sewage, even after sufficient treatment to reduce the biochemical oxygen demand (BOD)by 90 percent before being released to receiving streams, depletes the dissolved oxygen in the stream during periods of low flow. The present municipal and industrial waste discharged to the Cottonwood River has a population equivalent BOD , after treatment, of 4,290. 19/ This is projected to increase to 10,380 in 2020 and 18,696 in 2070.

Industrial wastes in this study area are primarily the wastes from the large cattle slaughtering and food processing industry centered at Emporia. These highly concentrated wastes, even after dilution with municipal wastes and 90 percent treatment at the municipal waste treatment facilities, add considerably to the total pounds of BOD which reach the stream.

A third source of pollution is the runoff from large cattle feedlots located primarily near Emporia, Strong City, Cedar Point, and Hillsboro. A localized rainstorm producing feedlot runoff, during periods of relatively low streamflow, have imposed a BOD load on the Cottonwood River depleting the dissolved oxygen and causing extensive fish kills. The Kansas State Department of Health is currently studying this problem and the means of controlling or reducing this pollutional load. The most feasible method at the present time appears to be the construction of retention ponds, or lagoons, to intercept the runoff from the feedlots. A properly designed lagoon would allow sufficient retention time to reduce the initial BOD loading by 90 percent or more before releasing the runoff to the stream in controlled quantities to eliminate the slugging effect which is presently occurring. The population equivalent (BOD) of the feedlot runoff, even after extensive control and treatment devices have been installed, is projected to be 7,924 in 2020 and 10,432 in 2070. Experiments are presently being conducted in at least two States, Kansas and Texas, to determine the practical feasibility and degree of reduction in BOD such a system of lagoons or retention ponds might be expected to have.

The dissolved solids concentration in the Cottonwood River is expected to increase due to the dissolved solids in the treated return flows. This concentration at times will exceed the Public Health Service Drinking Water Standards of 500 mg/l. However, the high concentration of dissolved solids in the dilution water available, approximately 440 mg/l, would necessitate a high ratio

of dilution flows to sewage return flows if a maximum of 500 mg/1 dissolved solids were to be maintained in the stream.

Minimum Streamflow Needs

The critical reach on the Cottonwood River in terms of depletion of dissolved oxygen is immediately below the town of Emporia, where the largest waste loadings occur. The minimum streamflows presented below in table VIII-1 will maintain a minimum of 4 mg/1 of dissolved oxygen at all times in the stream. Four milligrams per liter of dissolved oxygen will support the varieties of fish which inhabit the area. Because of the high summer stream temperatures, and consequently, low dissolved oxygen saturation values, a standard of greater than 4 mg/1 would be difficult to maintain.

Table VIII-1

Minimum Streamflow Requirements
Cottonwood River at Emporia

Month	Minimum Streamflow* (cfs) 2020	2070
January	11.2	19.5
February	11.2	19.5
March	11.2	19.5
April	18.6	30.5
May	32.4	51.5
June	42.8	68.8
July	56.1	91.4
August	56.1	91.4
September	42.8	68.8
October	32.4	51.5
November	18.8	30.5
December	11.2	19.5
Annual Average	28.8	46.9

* Includes sewage returns of 11.2 cfs and 19.5 cfs for the years 2020 and 2070, respectively.

Water Quality Storage Requirements

In order to maintain the minimum streamflow requirements just presented, it will be necessary to augment the natural streamflow with releases from upstream reservoirs during periods of low flow. The natural streamflows assumed are those low flows expected once-in-50 years (98 percent exceedence interval) on the Cottonwood River.

This level will provide a high degree of protection to the water supply storage in John Redmond Reservoir.

Marion Reservoir and Cedar Point Reservoir (see figure III-1) will operate as a unit in augmenting low flows on the Cottonwood River. The total augmentation needs on the Cottonwood River to maintain the minimum streamflows presented in table VIII-1 are 7,300 acre-feet per year in 2020 and 13,100 acre-feet per year in 2070. Marion Reservoir will provide a draft-on-storage* yield of 4,000 acre-feet per year. Thus, the draft-on-storage needs from Cedar Point Reservoir are 3,300 and 8,100 acre-feet per year for 2020 and 2070, respectively. The year of first need for Cedar Point releases is 1980, Marion quality releases being sufficient for the present and future until 1980.

The net additional flows needed on the Cottonwood River to maintain the minimum streamflows presented in table VIII-1 are summarized in table VIII-2.

Table VIII-2

Net Water Quality Control Requirements
(acre-feet per year)

Reservoir	Annual Draft-on-Storage 2020	2070
Marion	4,000	4,000
Cedar Point	3,300	8,100
Total Need	7,300	12,100

Table VIII-3 presents an estimated monthly release schedule as a percentage of the total annual releases from Cedar Point Reservoir for water quality control. This release schedule is not intended to be used as a reservoir operating plan. Actual releases will be dependent upon stream quantity and quality conditions as they occur. Table VIII-3 is being provided only as an indication of a possible release pattern.

* Annual draft-on-storage is the sum of the incremental excesses of needed releases over inflows during a year.

Table VIII-3

Water Quality Control Monthly Release Schedule
Cedar Point Reservoir

Month	Percent of Annual Draft-on-Storage
June	6
July	30
August	33
September	17
October	10
November	4

IX. BENEFITS

Municipal and Industrial Water Supply

The benefits of developing Cedar Point Reservoir for water supply result from the provision of an adequate and dependable source of water for future growth.

In practice, a measure of the benefits can be approximated as the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project.

Ground water is an unsatisfactory alternative to water supply storage in Cedar Point Reservoir because the potential yield of the Cottonwood River alluvium is not sufficient to meet the projected demands, particularly during periods of low streamflow.

Water supply storage in John Redmond Reservoir is a possible alternative to storage in Cedar Point Reservoir. However, the cost of transmission of water from John Redmond Reservoir upstream to Emporia would make the total cost of this source of supply exceed the cost of storage in Cedar Point Reservoir.

The most likely alternate to the Cedar Point Reservoir water supply storage would be the construction of a single-purpose water supply reservoir at the proposed Cedar Point site. The cost of a single-purpose reservoir, having an annual yield of 7.0 mgd, is estimated to be $6,116,300, with an annual operation and maintenance cost of $30,300, and a major replacement cost of $1,700.

The average annual cost of this project, financed at 3 1/8 percent over its 100-year life, is $232,360. Water supply storage is not needed until the year 2005, however. The capitalized value of the annual costs in 2005 for the 65-year interval from 2005 to the end of the period under study, 2070, is $6,429,380.

The sequence of building the single-purpose alternate and major expenditures would necessarily begin about 5 years before the time of first need which would allow for planning and construction. Since the time of first need has been determined to be 2005, it is necessary to discount the capitalized value from 5 years before that date, or 2000, to the base year of 1970.

The capitalized value of the annual cost in 1970 is therefore $2,554,200. The annual value of the capitalized cost in the year 1970, amortized at 3 1/8 percent over the 100-year study period, 1970 to 2070, is $83,700.

The annual value of benefits for storage in the proposed Cedar Point Reservoir for water supply is approximated as the average annual

value of storage in the most likely alternative. The annual value of benefits for municipal and industrial water supply storage in the proposed Cedar Point Reservoir has a present (1970) value of $83,700.

Water Quality Control

Benefits attributable to storage for streamflow regulation for water quality control may be tangible or intangible.

Representing intangible benefits, water quality control by the proposed Cedar Point Reservoir will provide recreational opportunities on the Cottonwood River for a distance of approximately 90 miles below the Cedar Creek confluence to the Neosho River confluence. Assured water quality will provide favorable conditions for recreation for those living in the study area, projected to be 130,000 persons by the year 2070. In addition to the recreational benefits, riparian property owners will enjoy improved aesthetics of the stream stemming from clean surface waters and a satisfactory public health water environment.

If required storage for streamflow regulation is not provided as recommended, the projected wastes loads of BOD will result in a dissolved oxygen concentration in the river at times approaching zero. Under such conditions, fish life in the stream would leave the area or be trapped in pools in the river bottom to die for lack of oxygen. The stream will become the source of various odors and approach a septic condition dangerous to public health.

Of more tangible benefit is the protection of the water supply storage in John Redmond Reservoir, located on the Neosho River immediately below its confluence with the Cottonwood River. Polluted waters entering this reservoir from the Cottonwood River could endanger this source of water supply for the lower Neosho Valley.

Senate Document No. 97 permits the following method of measuring benefits of storage in Federal reservoirs for water quality control:

> "In situations where no adequate means can be devised to evaluate directly the economic effects of water quality improvement, the cost of achieving the same results by the most likely alternative may be used as an approximation of value."

The most likely alternative to water quality control storage in Cedar Point Reservoir would be a single-purpose reservoir at the same site to yield 8,100 acre-feet per year draft-on-storage. The first cost of such a reservoir would be $9,317,000, the operation and maintenance would be $67,100 annually, and the annual major replacement cost would be $3,800. Converting these reservoir costs to equivalent annual costs using a project life of 100 years and a Federal interest rate of 3 1/8 percent, the annual cost of this alternate would be $376,120.

The year of first need for water quality control releases from Cedar Point Reservoir is 1980. The capitalized value of the annual costs in 1980 for the 90-year interval from 1980 to the end of the study period, 2070, is $11,281,300. The sequence of building the single-purpose alternate and major expenses would necessarily begin about 5 years before the year of first need, or 1975. Thus, the capitalized value of the annual costs must be discounted for a period of 5 years, from 1975 to the base year of the study, 1970. The present (1970) value of the capitalized cost is therefore $9,672,510. The present annual value of the capitalized cost, amortized at 3 1/8 percent over the 100-year study period, 1970 to 2070, is $316,860.

The annual value of benefits for storage in the proposed Cedar Point Reservoir for water quality control is estimated to be the annual value of the capitalized cost of the most likely alternative, or $316,860.

Since water quality control management by the proposed Cedar Point Reservoir will assure water quality in the Cottonwood River for a distance of approximately 90 miles and thereby provide recreational opportunities for an estimated potential population of 130,000 as well as eliminating a potential source of pollution to John Redmond Reservoir, benefits to water quality control storage in the project are considered widespread in scope.

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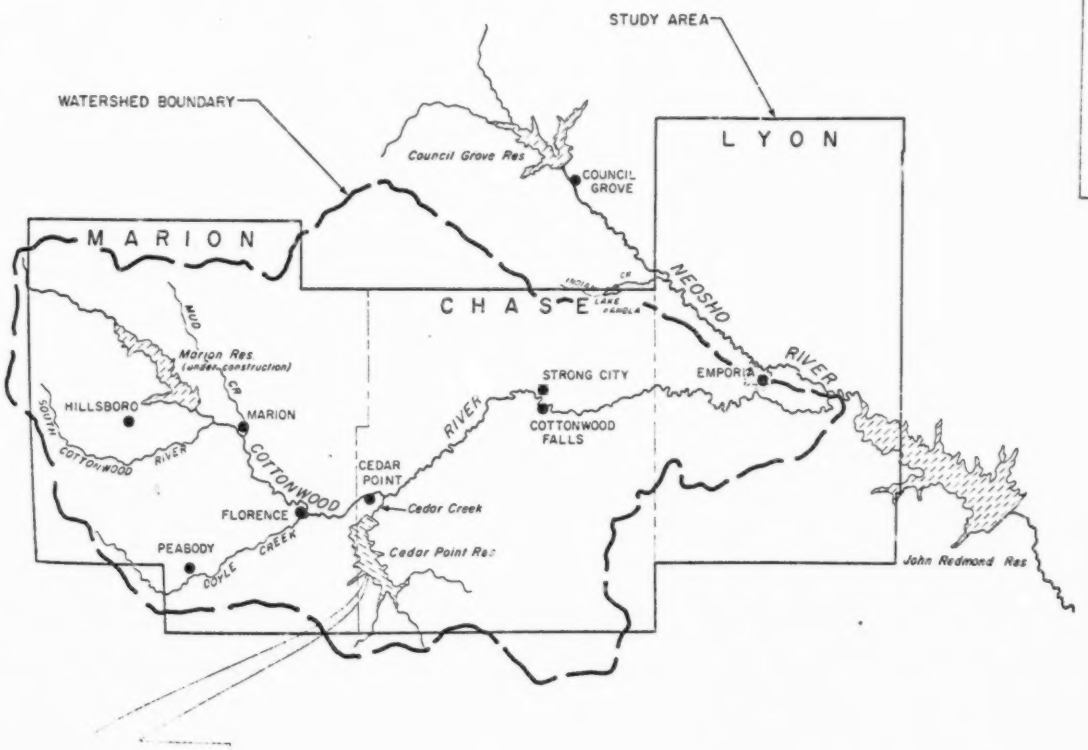

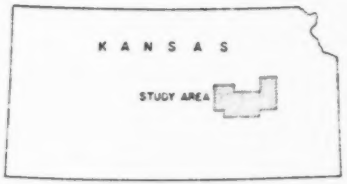

VICINITY MAP

PROJECT

Scale in Miles
10 20 30

WATER SUPPLY & WATER QUALITY CONTROL STUDY
CEDAR POINT RESERVOIR—CEDAR CREEK
COTTONWOOD RIVER BASIN, KANSAS

LOCATION MAP

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

FIGURE III-1